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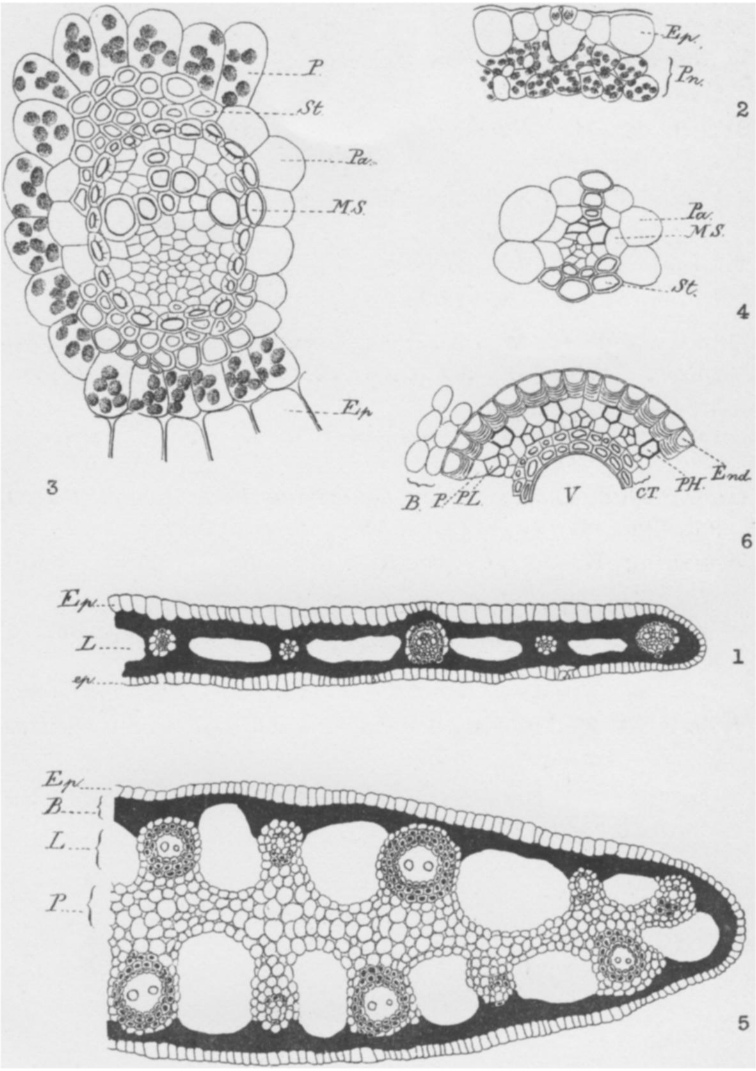

Theo. Holm ad. nat. del.

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Juncus repens Michx.—A Morphological and Anatomical Study

By Theo. Holm

(With Plate 363)

Botanical literature already possesses a number of valuable contributions to a knowledge of the Juncaceae from the writings of Buchenau, Engelmann and Kunth, and the laborious works of these authors have furnished botanists not only with diagnoses of a number of species and varieties, but also with data relating to the natural history of this order of plants. The *Monographia Juncacearum* is a work so complete and exact, that it is difficult even for the field-botanist to detect any additional facts that are worthy of being recorded. Therefore, in presenting some observations upon *Juncus repens*, we wish them to be considered only as supplemental to the diagnosis already given, and we desire besides to show some peculiarities in the structure, which we noticed contemporarily with our researches on the North American species of *Fimbristylis*.

In a morphological respect *Juncus repens* affords several points of interest, and occurs under two forms, terrestrial and aquatic, the first representing the most typical growth of the species. Characteristic of both forms is, however, the profuse development of vegetative shoots, especially in the latter, where vegetative propagation predominates. Flowers develop, nevertheless, in both forms, even when the plant is submerged, but the typical floral shoots are to be found only on terrestrial specimens.

Although the rhizome is very short and cespitose, the plant is, nevertheless, able to cover a large area by means of its vegetative shoots borne on prostrate stems with long internodes and by rooting very freely. The structure of these prostrate stems is so much like the flower-bearing ones, that they might be considered as modified floral shoots. They both are distinctly compressed and provided with typical leaves having sheaths and blades, but on the vegetative branches the flowers are replaced by fascicles of shoots. The number of flowers and leafy shoots varies very much and it is not uncommon to find only a few sessile flowers developed among purely vegetative shoots; however, in no instance have we been able to detect flowers that were partly transformed into leaves. The flower-bearing stem consists of several, four or five, stretched internodes, while in the prostrate, vegetative shoots the basal internode is commonly the only one that is visible; specimens in which two or three very distinct internodes are developed are not infrequent however. When two or three long internodes are developed they alternate with a series of short ones each bearing a leaf with axillary shoots. In this manner the species well deserves to be termed as "repeatedly proliferous." None of these vegetative shoots become freed, however, from the mother-plant so as to form new individuals in any other way than by the gradual dying away of the long stem internode. Hence the vegetative propagation is different from what Buchenau has described as characteristic of *Juncus pelocarpus*, where similar small shoots develop in the inflorescence but drop off, producing new individuals.

By examining the flower-bearing stems, we find them similar to the vegetative branches, very strongly compressed but narrower, and they occur as axillary or as terminal; in the first case, they begin with a periphyllon, bicarinate and membranous. The flower-bearing stems are, furthermore, leafy, possessing usually two or three leaves at the base and several some distance above, each supporting a minor inflorescence of a few, nearly sessile flowers, borne on a peduncle of various length. Contrary to our expectation these axillary peduncles are destitute of prophylla at their base even in cases where they have attained a considerable length.

In passing to examine the leaves, our plant demonstrates the singular fact of possessing "distichous leaves with compressed sheaths and broadly linear, flat blades, which turn the one margin towards the stem." Viewed superficially the leaf-blades remind one of the ensiform leaves of *Iris*, but it is readily seen by closer examination that it is merely a twisting of the blade, that has taken place. The flattened stems correspond well with this peculiar structure of the leaf-sheaths and with the partial twist of the blade. It is a structure which we have, furthermore, observed in one of our native species of *Fimbristylis*, *F. autumnalis* R. & S., besides in its southern ally *F. complanata* Link. It seems to be rare in the Juncaceae, but is evidently characteristic of *Juncus obtusatus* Engelm. and of *J. falcatus* E. Mey. judging from the diagnoses in Buchenau's monograph: "lamina interdum oblique ad latus deflexa, inde falcata."

The shoots of *Juncus repens* are hence very strongly flattened throughout, and similar to what we have observed in *Fimbristylis* the leaves are truly distichous, besides turning the blades alternately to right and left, thus all the blades on the one side of the shoot point in an opposite direction to those on the other side. This peculiar position of the leaf-blade in *Juncus repens* has not, however, resulted in acquiring the same internal structure as is characteristic of the two species of *Fimbristylis*, mentioned above, In this respect our *Juncus* agrees nevertheless, better with its nearest relatives among the "*Junci graminifolii*" than with the exceptional case among the Cyperaceae, cited from *Fimbristylis*.

Let us examine the structure in both in order to draw the comparison as precise as possible. A leaf, or rather the half of a leaf-blade of *Juncus repens* (Plate 363, Fig. 1) shows, as far as concerns the epidermis, a dorsiventral blade with the cells somewhat larger on the upper than on the lower face. Moreover the upper epidermis is developed as thin-walled bulliform-cells in the entire width of the blade, in which respect it agrees with both species of *Fimbristylis*. The structure of the mesophyll, however, is very different, being in *Juncus* differentiated into a palisade- and a pneumatic-tissue, while in *Fimbristylis* only the palisade-tissue is developed. The palisade-tissue in *Juncus repens* consists, furthermore, of shorter cells, which are not arranged as regularly radiating around the mestome-bundles as is the case with *Fimbristylis*. Large lacunes traverse the mesophyll in *Juncus* and are interrupted only by obliquely placed diaphragms, accompanied by mestome-anastomoses, small mestome-bundles which pass from the mestome of the larger bundles through the interior of the diaphragms and finally connect with the mestome of another bundle. Similar lacunes are characteristic of Juncaceae, but were not observed in the two species of *Fimbristylis*. Considering the stereome our *Juncus* possesses no sub-epidermal groups of this tissue and there is none in the leaf-margins either. But bordering immediately on the mestome-sheath of the ribs are small stereome-groups to be observed of relatively thin-walled cells, separated from epidermis by mesophyll. In *Fimbristylis* on the other hand the stereome is sub-epidermal and is not in contact with the ribs, these being "pure mestome-bundles." The mestome-bundles (Plate 363, Fig. 3) are surrounded by a colorless, thin-walled parenchyma-sheath, which, on the leptome- and hadrome-side, is interrupted by stereome. Inside of this sheath follows a mestome-sheath of distinctly porose and thick-walled cells, which is perfectly closed and directly surrounds the leptome and hadrome. If we examine the smallest bundles in the same leaf we notice a similar structure, but the mestome-sheath is less conspicuous since only a few of its cells are thick-walled. The drawing (Plate 363, Fig. 4) shows only one slightly thick-walled cell on the hadrome-side and three on the leptome, the other part of the mestome-sheath being thin-walled similar to the parenchyma-sheath outside.

In comparing this structure of the mestome-bundles in our *Juncus* with those of *Fimbristylis*, we notice the total absence of the inner chlorophyll-bearing sheath in *Juncus*. This sheath which we have described and figured in a paper on *Fimbristylis* (*Amer. Jour. of Science*, 1899) seems characteristic of a number of Cyperaceae, but its development does not appear to depend on any certain shape or position of the leaf-blade. In *Juncus repens* the linear leaf-blade, as described above, is held in exactly the same position as that of *Fimbristylis autumnalis*, besides that these plants inhabit much the same localities, yet the leaf-structure is different in both. It is evident that the inner chlorophyll-bearing sheath is characteristic only of certain Cyperaceae, and perhaps only of those in the leaves of which the mesophyll is restricted to palisade sheaths around each individual mestome-bundle.

The leaf of *Juncus repens*, in the terrestrial form, is as we have seen from the above bifacial and shows a rather open structure on account of the wide lacunes. If we examine the submerged form we observe the same structure and a similar position occupied by the leaf-blade, but the lacunes are much wider and the cells of epidermis of the upper face are not much larger than those of the lower.

In regard to the internal structure of the prostrate stem (Plate 363, Fig. 5), this corresponds in most particulars with that of the erect, flower-bearing one. The prostrate stem, however, is broader and somewhat more compressed than the other. The outer cell-wall of epidermis is slightly thickened and the cells are sometimes developed as bulliform, especially outside the lacunes. The bark-parenchyma contains chlorophyll and consists of palisades. Similar to the leaf the mechanical tissue is poorly represented in the stem and occurs only as small groups on both faces of the mestome-bundles, but without being in contact with epidermis, and without forming any closed ring around the inner part of the stem. The mestome-bundles, the large and small ones, form only one peripheral band and their structure corresponds exactly to that of the leaf-bundles. There is a starch-bearing pith, which occupies the inner part of the stem ; it is, together with the bark, interrupted by lacunes, which are somewhat larger in the prostrate, than in the erect, flower-bearing stem. This structure of the stem does not seem different from that of other species of *Juncus*, examined so far, with the exception of the arrangement of the mestome-bundles in two nearly parallel planes on account of the compressed outline. In the cylindric stems the mestome-bundles lie in one concentric band, and the pith occupies the innermost part of the central cylinder, interrupted by a single or several concentric lacunes.

As very little is known of the root-structure in North American Juncaceae, we might state, that there is a persisting hypoderm of only one stratum and that the bark-parenchyma collapses radially with the exception of the innermost two layers, which border on the endodermis. The inner cell-walls of endodermis are very much thickened (Plate 363, Fig. 6) and show a number of layers. The pericambium is thin-walled and very regularly interrupted by the proto-hadrome vessels, there being invariably only two pericambium-cells outside the leptome. A large vessel occupies the center of the root, and is surrounded by two strata of thick-walled conjunctive-tissue. The interruption of the pericambium by the rays of the hadrome, the proto-hadrome vessels, is a character which the Juncaceae, at least a number of species, have in common with several genera of Gramineae, Cyperaceae, Centrolepideae, etc. Besides this the presence of a mestome-sheath is another character which is known to occur in all the Cyperaceae examined, but not in all the Gramineae; according to Schwendener it has not been observed in any of the Andropogoneae or Maydeae, or in several genera of Paniceae. Considered from an anatomical view point

Juncus repens shows no character by which it can be considered generically distinct from any *Juncus*. Neither does its morphological characters taken from the vegetative organs warrant any separation, and the peculiar septifragal dehiscence of its capsule, upon which Desvaux established *Cephaloxys flabellata* is not without intergradating forms within the genus.

BIBLIOGRAPHY.

Buchenau, Franz. Monographia Juncacearum. (Engler's bot. Jarb. Vol. 12. Leipzig. 1890.)

Buchenau, Franz. Kleinere Beiträge zur Naturgeschichte der Juncaceen. (Abhdl. d. naturw. Verein. Bremen. **2**: 392. 1870.)

Desvaux, N. A. Observations sur trois nouveaux genres de la famille des Joncinées. (Journ. de Botanique. **1**: 321. 1808. Paris.)

Engelmann, Georg. A revision of the North American species of *Juncus* with a description of new or imperfectly known species. (Trans. St. Louis Acad. Sci. **2**: 424. 1865.)

Kunth, C. S. Enumeratio plantanum. Stuttgart. **3**: 346. 1841.

Michaux, A. Flora Boreali-Americana. **1**: 191. Paris. 1803.

Schwendener, S. Die Mestomscheiden der Gramineenblätter. (Sitzungsber. d. k. Acad. Wiss. Berlin. 1890: 305.)

Van Tieghem, Ph. Recherches sur la symétrie de structure des plantes vasculaires. (Ann. sc. nat. Botanique. **13**: Paris. 1870.) See also Journal de Botanique. **1**: 305. Paris.

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Explanation of Plate 363.

FIG. 1. Transverse section of half of the leaf-blade of *Juncus repens*. *Ep.*, epidermis of upper face; *L*, lacune; *ep.*, epidermis of lower surface, × 75.

FIG. 2. Stoma from the leaf; *Ep.*, epidermis of lower surface; *Pn.*, pneumatic tissue, × 320.

FIG. 3. Large mestome-bundle from leaf, transverse section; *P.*, palisades; *St.*, stereome; *Pa.*, parenchyma-sheath; *M. S.*, mestome-sheath; *Ep.*, epidermis of lower surface, × 560.

FIG. 4. Small mestome-bundle from leaf, transverse section; letters as in Fig. 3, × 560.

FIG. 5. Stem-part, transverse section; *Ep.*, epidermis; *B.*, bark; *L.*, lacune; *P.*, pith, × 75.

FIG. 6. Transverse section of a part of the root; *B.*, bark; *P.*, pericambium; *P. L.*, proto-leptome; *P. H.*, proto-hadrome; *V.*, vessel; *C. T.*, conjunctive tissue; *End.*, endodermis, × 400.